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ABSTRACT

This study was conducted to identify: (1) the changes in the learning environment of secondary school science and mathematics from 1972 to 1976; and (2) the effect of subject matter and grade level on the student's perception of the learning environment. The Learning Environment Inventory (LEI) which consists of 10 seven-item scale was administered by teachers to collect data from sampled classes in 15 states. A three-way multivariate analysis of variance (MANOVA) was used to analyze data. The three factors were year (1972, 1976), subject (science, math), and grade level (junior, senior high) of the students. Results showed that the students' perception of the social environment had changed significantly during the four year period. Significant subject and grade level differences were also found. These findings suggest the presence of duration, curricular and age effects on the student's perception of the learning environment. (HM)

RESEARCH PAPER #24

A Long-Term Study of the Stability of Learning Environments

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A LONG-TERM STUDY OF THE STABILITY OF LEARNING ENVIRONMENTS

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INTRODUCTION

Many educators are fond of making statements which describe the ebb and flow of the educational environment. For example, we often hear statements like "teaching is much different today than it was 5 years ago". Or, "how can you, a college professor, know what schools are like when you haven't taught in one for ten years". And our conversations are sprinkled with references to the swinging pendulum of a series of educational innovations; for example, progressive, open, curriculum development, evaluation, accountability, back-to-basics, assessment, behavioral objectives, minimum competencies, individualized, and the like.

To some, the institution of education is in a constant state of flux--to others, there are only ripples on an ocean of constancy. The grinding glacier of educational practice veers very little from paths well established during a century of American education.

As in most educational arguments, support probably could be found for both points of view. There is change and there is constancy. But the extent to which each exists seems worthy of further investigation. Can evidence be obtained which suggests educational environments are constant over time, or are there changes in the social environment of learning that can be detected by our present instruments? Such is the general problem of this study.

In the past two decades the study of school environments has emerged as an important area of social science research (Anderson and Walberg, 1974; Nielsen and Kirk, 1974). Measures of the environment (or climate) have focused on teacher behavior (Medley and Mitzel, 1958; Amidon and Flanders, 1963) and on the environmental press as perceived by students (Stern, Stein and Bloom, 1956; Steele, House and Kerins, 1971; Anderson and Walberg, 1974). It is the latter approach that seems to offer the most promising potential for understanding the educational process because student perceptions of the school environment have been shown to be related to student learnings (Walberg, 1969). Furthermore, environmental variables can be predicted from such things as mean intelligence, student interest, class size, and instructional variables.

Differences among curricula (Welch and Walberg, 1972; Walberg, 1974) and grade level (Shaw and Mackinnon, 1973) have been noted. Furthermore, student perceptions of the learning environment in science classes as measured by the Learning Environment Inventory (LEI) have been shown to be stable across rather short time durations (Lawrenz, 1977). But the long term stability, or variations, in educational environments heretofore have not been investigated.

Such investigations would appear to have implications for educational policy makers. If the learning environment is stable in spite of perceived institutional demands, sanctions, and expectations, such things as curriculum materials, instructional techniques and teacher training would require little variation across time. Today's teacher could easily function in tomorrow's (or yesterday's) world. On the other hand, if the class environment does vary in response to social pressures or student changes, then we must

conceptualize a fluid education system. Curriculum renewal, teacher in-service, and revised pedagogy all take on increased importance. Such considerations give rise to the problem of this paper: To what extent are there long-term changes on a measure of the social environment of learning in secondary school science and mathematics classes? Because past research has suggested some environmental differences related to the curriculum and to the grade level of the student (Walberg, 1974; Anderson, 1971), these factors are also included in the present study.

PROBLEMS

There are three specific questions to be investigated in this study.

1. Did student perception of the learning environment in secondary (ages 12-17) science and mathematics classes change during the four-year period, 1972-1976?
2. Do students perceive a different learning environment in science and mathematics classes?
3. Is the learning environment of the junior high level (ages 12-14) different from that of the senior high level (ages 15-17)?

PROCEDURE

Sample

A stratified random sample of all the secondary schools in 15 states* located in the western two-thirds of the continental United States was used

*The states were California, Idaho, Utah, Montana, Wyoming, Colorado, North Dakota, South Dakota, Nebraska, Minnesota, Iowa, Michigan, Indiana, Mississippi and Alabama.

in this study. These states were selected because this study is part of an evaluation study in this 15 state region (see Welch and Gullickson, 1973, for details).

Within each school, one science or math teacher was selected at random and that teacher randomly selected one of his/her classes. A participation rate of 53% in 1972 was obtained. In 1976, the percentage of schools agreeing to participate dropped to 45%, reflecting a perception many have regarding the increasing difficulty of gathering school data. Follow-up studies of nonparticipants both years suggest little differences between participating and nonparticipating schools (Sandman, 1972; Studer, 1977).

The final sample comprised 563 classes in 1972 and 558 classes in 1976. Evaluation needs apart from the present study required that the sample in 1976 contain about 50% repeaters from the 1972 sample. The complete testing plan is shown in Table I.

TABLE I

Classroom Testing Plan

1972

	Jr High	Sr High	
Science	108	242	350
Math	99	114	213
	207	356	563

1976

	Jr High	Sr High	
Science	122	235	357
Math	86	115	201
	208	350	558

It is important to note that the above figures refer to classes and that each class contains approximately 22 students. A randomized data collection procedure (Walberg and Welch, 1967) was used such that only one-third of the

science class and one-half of the math students participated in the study. (The remaining students in each class were given other instruments.) Thus, the total number of students in the study exceeded 24,000. However, the unit of analysis is the mean of the students in a given class who responded to the Learning Environment Inventory (LEI). Data were obtained from 1,121 such classes.

TEST INSTRUMENT

Student perceptions of the social environment of learning were obtained using the Learning Environment Inventory (LEI). This instrument was developed by Walberg and Anderson (1968) and was designed to describe the nature of the interpersonal relationships in the class as well as its structural characteristics. The LEI meets acceptable levels for reliability, is easily administered, and has been shown to be related to student learning.

The version of the LEI used in this study (Form F) consists of 10 seven-item scales. Students are asked to express their agreement or disagreement with each statement on a four-point scale. Testing time limitations required a modification of the original 15-scale instrument. The ten scales selected for the study were those shown to be particularly sensitive to differences in math and science classes (Anderson, 1971).

The ten scales, a sample item, and the reliability of the scale are presented in Table II.

TABLE II

Learning Environment Inventory Scales
Form F

Scales		Reliabilities Alpha	Reliabilities Intraclass
Diversity	The class divides its efforts among several purposes.	.53	.31
Formality	Students are asked to follow a complicated set of rules.	.76	.92
Friction	Certain students are considered uncooperative.	.72	.83
Goal Direction	The objectives of the class are specific.	.85	.75
Favoritism	Only the good students are given special projects.	.78	.76
Difficulty	Students are constantly challenged.	.64	.78
Democratic	Class decisions tend to be made by all the students.	.67	.67
Cliqueness	Certain students work only with their close friends.	.65	.71
Satisfaction	Students are well-satisfied with the work of the class.	.79	.84
Disorganization	The class is disorganized.	.82	.92

ADMINISTRATION AND ANALYSIS

The LEI was administered by teachers in early spring of 1972. It was part of a larger test battery being used in a national evaluation of in-service programs for teachers. Optically-scanned answer sheets were mailed to a central processing facility where they were all checked, cleaned and scored. Class means on each of the 10 variables were obtained and submitted to a three-way multivariate analysis of variance (MANOVA). The main effects due to year (1972, 1976), subject (science, math) and grade level (junior, senior high) were examined with alpha set at the .05 level.

The multivariate procedure is a generalization of analysis of variance when working with several dependent variables. (In this case, these are the 10 LEI scales.) Its purpose is to determine whether statistically significant differences exist between two or more groups on a set of dependent variables. If a statistically significant multivariate F is obtained ($p < .05$), we can reject the null hypothesis of equal group centroids. Subsequent examination of the several univariate F values allows us to determine which of the variables discriminates best between the groups (Amick and Crittenden, 1975).

The basic design for this study is a three-way (2 x 2 x 2) factorial design. The factors of interest are year, subject and grade level of the students. The major concern of this paper is the stability of the LEI scales between 1972 and 1976. Secondary purposes include the effect of subject matter (science and math) and grade level (junior versus senior high school) on the students' perception of the learning environment.

RESULTS

The results of the multivariate analysis of variance are shown in Table III. The major finding for this study is the statistically significant difference (p = .002) between 1972 and 1976. This means that on the 10 LEI scales taken together, there were observed differences across the four years that could not reasonably be attributed to chance.

TABLE III

Multivariate F-Values for Analysis of Variance
10 Scales of Learning Environment Inventory

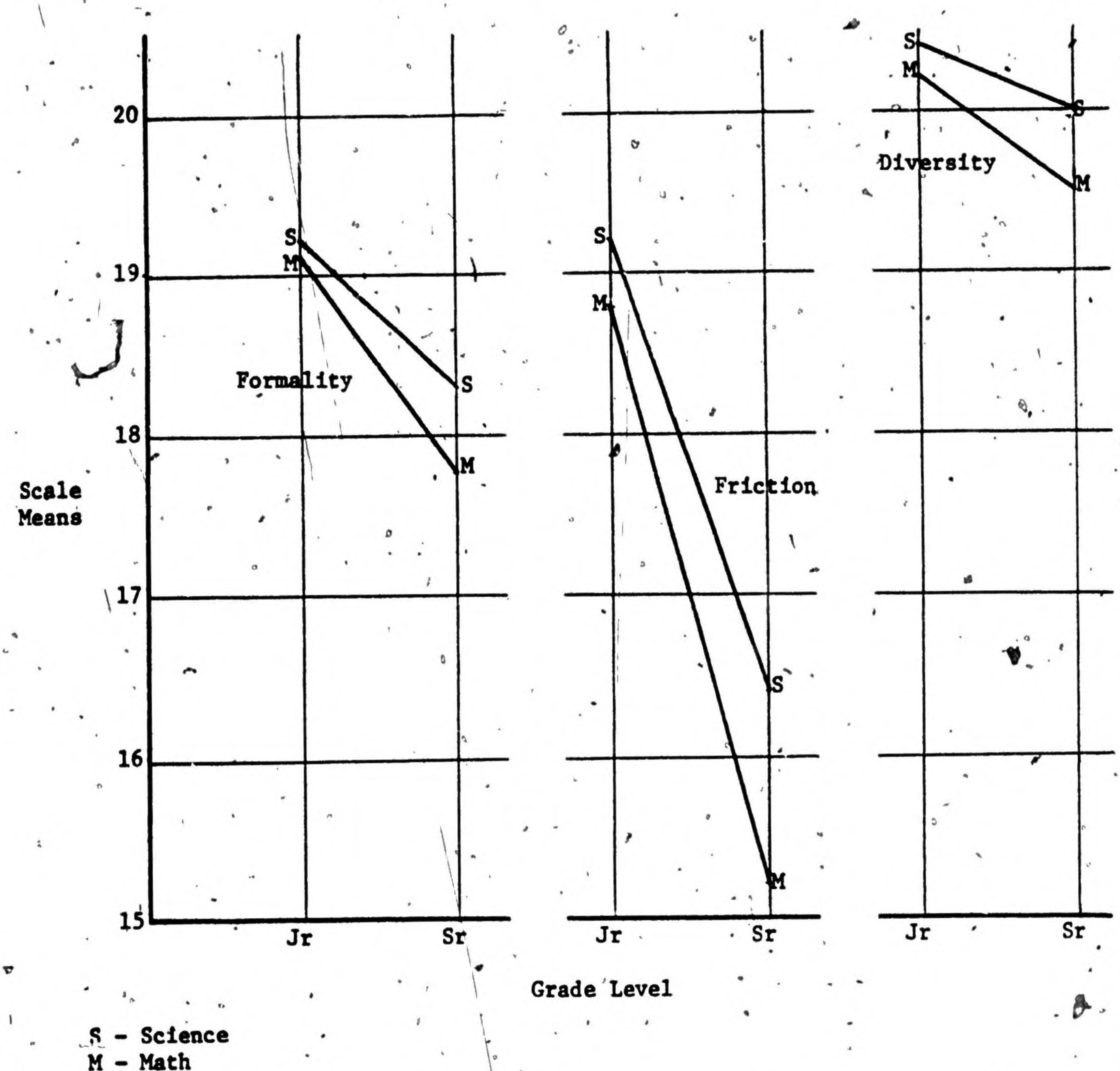
SOURCE OF DISPERSION	MULTIVARIATE F-VALUE	SIGNIFICANCE OF F
Main Effects		
Year	2.80	.002
Subject	27.71	<.001
Grade Level	78.30	<.001
Interactions		
Year by Subject	0.54	.866
Year by Grade	1.53	.125
Grade by Subject	4.94	<.001
Year by Grade by Subject	0.43	.931

Degrees of freedom 10, 1104

Similar results were obtained for the comparisons between math and science, and between junior and senior high students. These findings suggest the presence of duration, curricular and age effects on the student's perception of the learning environment.

Three of the four interactions failed to reach the level established for statistical significance (p < .05). However, there was a significant multivariate interaction between grade (junior and senior high) and subject

Figure 1
Significant Interactions
Grade by Subject



(science or math). This suggests that on some of the LEI scales, the junior-senior changes are different for science and mathematics.

Examination of the univariate f-values for the LEI scales indicated three significant ($p < .05$) interactions on the scales labeled Formality, Friction and Diversity. All were of the same form; senior high scores were lower than junior high, but the science-math differences were greater for the older students. The interactions are shown schematically in Figure 1.

The nature of the interactions are such that it seems reasonable to examine the main effects in more detail. That is, in all cases the science mean is higher than the math mean, and junior high scores exceeded those at the senior high. Furthermore, no interactions were noted for the year effects, the primary problem of the study.

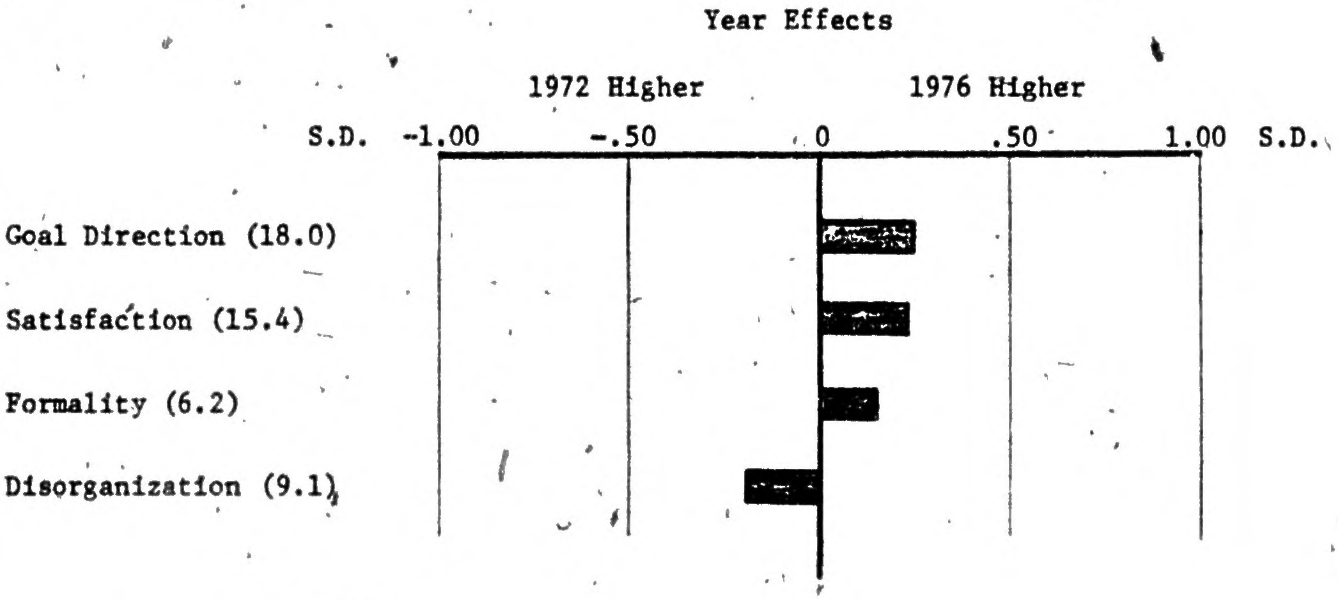
Because the multivariate tests of the three main effects reached the chosen significance level, the univariate F-tests were examined to determine which LEI scales showed the greatest differences. A standardized effect contrast was computed for the significant LEI scales ($p < .05$). (The standardized contrast was obtained by dividing the main effect differences by the within-group standard deviation.) The significant contrasts across years are presented in Figure 2.

Four of the 10 univariate tests were significant at the $p < .05$ level and are shown in Figure 2. Students in 1976 perceived their classes to be more organized, formal, goal directed and satisfying than their counterparts in 1972.

Disorganization (or its converse, organization) refers to the extent to which pupils consider the class disorganized. It is negatively related

Figure 2

Significant* Standardized Contrasts



*p < .05
f-ratios in ( )

to pupil learning. Sample items include "Many class members are confused during class meetings" and "The work of the class is frequently interrupted when some students have nothing to do".

A formal classroom is one which is guided by well-established rules. Students who break the rules know they will be penalized, and there are recognized right and wrong ways of going about class activities. In past studies, the scale has not been related to student learning.

Goal direction also refers to the structure of class activities. Recognition of goals by the group and their acceptance characterizes high goal direction classes.

These three variables clearly portray an environment that is a shift toward a more orderly or structured learning climate. A change to a more

conservative environment seems to have taken place during the four year period. Furthermore, students find the 1976 learning environment to be more satisfying than that of 1972.

A second problem of the study was to determine the extent to which differences exist between math and science classes. As was noted in Table III, a statistically significant result ($p < .001$) was found for the effect due to subject matter. Stated more precisely, science students perceived their learning environments differently from math students. The specific subscales of the LEI where this was most pronounced are shown in Figure 3.

Nine of the 10 LEI scales showed significant differences between math and science. Science classes were seen as more diverse, disorganized and formal, and were thought to possess higher levels of friction, cliqueness and favoritism.

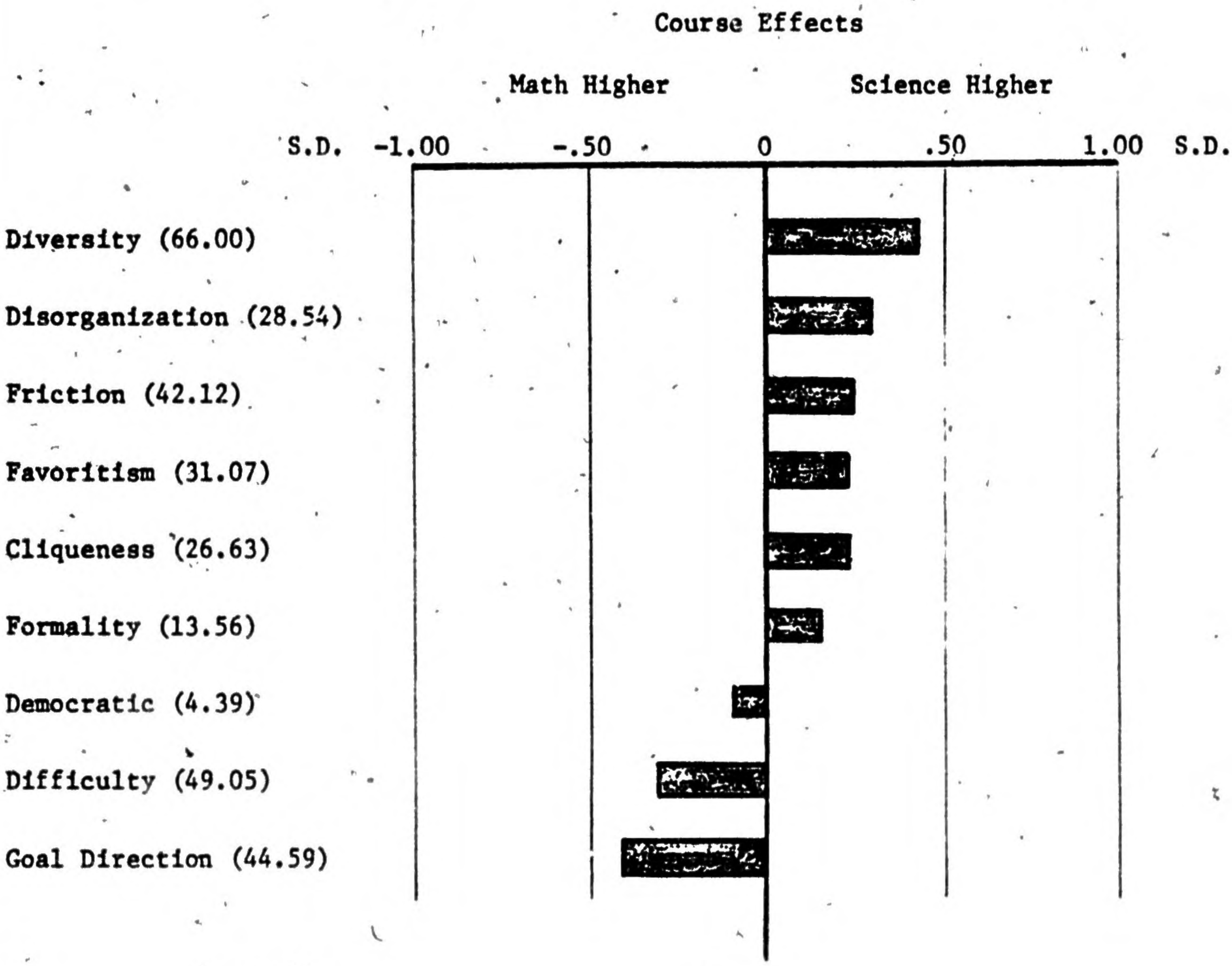
Math students perceived their classes higher on the Goal Direction, Difficulty and Democratic scales. The classes were about equal on the Satisfaction scale.

These findings are contrary to Anderson's (1971) study comparing nine mathematics and 26 science classes in eight Montreal schools. In fact, five of the differences are opposite to Anderson's results, only two are in agreement (formality and difficulty), and one (diversity) reached the chosen statistical level here but not in the previous study.

It is informative to note that Anderson's hypothesized results for a more activity prone subject as science are supported in the current study, yet refuted in his own study. Science classes usually contain a substantial laboratory component, vary considerably in their subject matter, and provide

Figure 3

Significant* Standardized Contrasts



*p < .05
f-ratios in ( )

many opportunities for social interactions. Accordingly, one might expect the class to be more disorganized and diverse with a greater likelihood of such things as cliqueness, friction and favoritism.

On the other hand, the conceptual structure and rule-orientation (logic) of mathematics would suggest a formal, goal-directed and perhaps difficult climate in a mathematics class.

With the exception of formality, these expectations are borne out in the present study. Although puzzling in terms of the above reasoning, science was seen as more formal in both this and the Anderson study.

The third question of this research was an investigation of climate differences between junior high classes (ages 12-14) and senior high classes (ages 15-17). The results of this comparison are presented in Figure 4 with the senior minus junior high contrasts shown.

The multivariate F value for this comparison was 78.3 and nine of the 10 univariate contrasts were significant. The magnitude of the grade level differences was greater than for the year or subject matter effects.

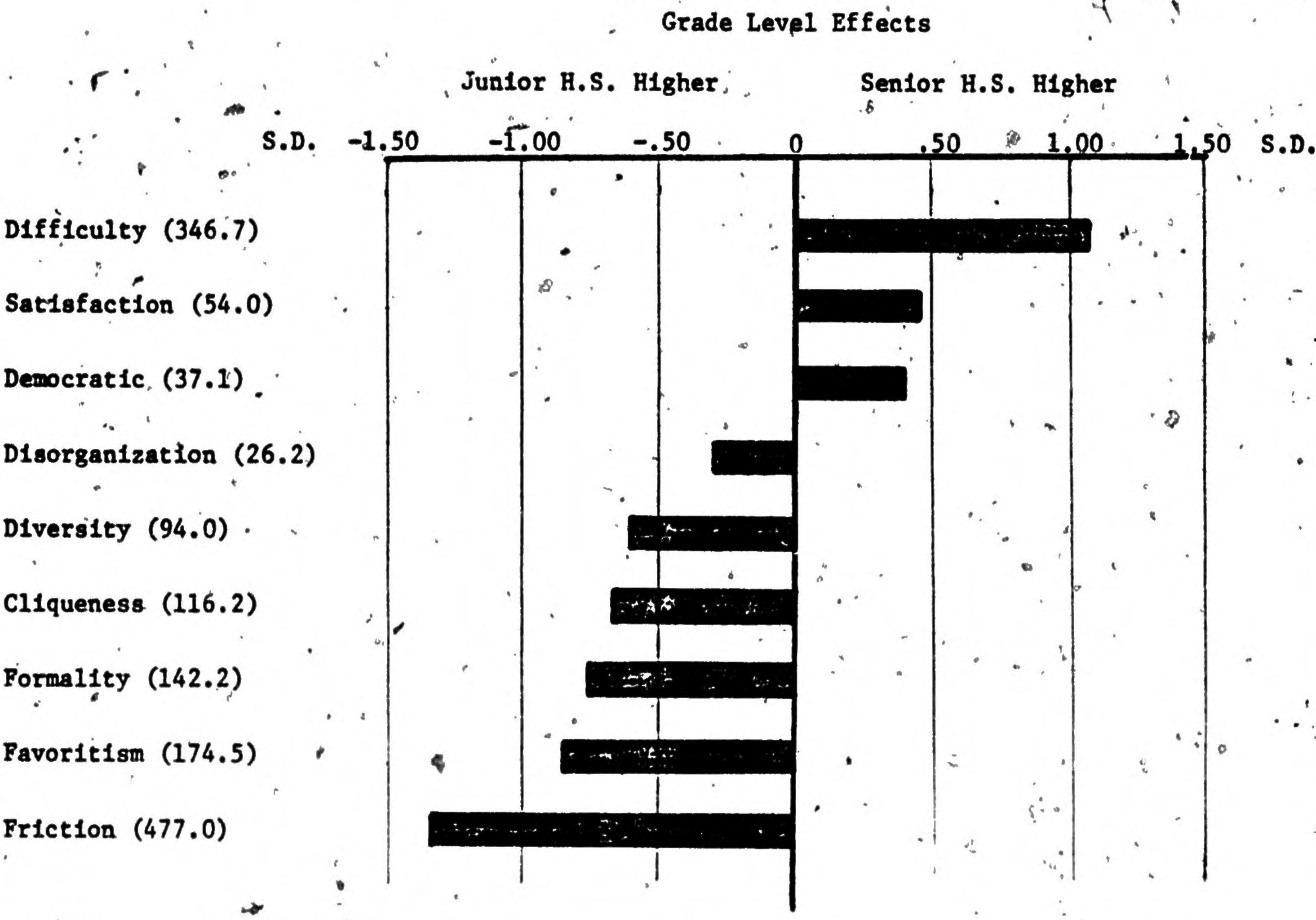
Senior high students saw their classes as more difficult, satisfying and democratic. On the other hand, junior high students perceived their classes as more disorganized, diverse and formal, with higher levels of friction, cliqueness and favoritism.

In general, these findings tend to support the results of previous work that suggests a more student and activity-centered environment for the junior high classes (Shaw and Mackinnon, 1973). Classes apparently are less structured with a greater variety of activities provided for (or generated by) students. At the same time, there is greater social conflict in the class (favoritism, cliqueness, friction, undemocratic) which leads to a generally unsatisfying situation.

The volatile characteristics of early adolescents seem to dominate the learning environment in junior high schools. This age group is very active and emotional. These characteristics would tend toward classes that are diverse and disorganized with greater likelihood of disappointing personal interactions, e.g., perceived cliqueness.

Figure 4

Significant* Standardized Contrasts



*p < .05
f-ratios in ( )

The results for the LEI scales Formality and Difficulty appear contrary to the above interpretation. Junior high classes were seen as more formal and less difficult.

Difficulty scores are highly related to measures of cognitive learning (Anderson, 1971) with pupils generally learning most in classes perceived as

most difficult. Because science and math are usually elective subjects at the higher grades, the senior high sample in this study is probably skewed. It contains a higher percentage of college-bound students who are enrolled in college-preparatory subjects. It seems likely the cognitive demands of these classes would be greater, resulting in more difficult classes. Certainly the severe grading practices in chemistry and physics would tend to support this conclusion (Bridgham, 1972).

The Formality findings are also somewhat surprising. However, they are consistent with the Shaw and Mackinnon study (1973) which found that formality scores declined progressively between the sixth and the twelfth grade. Perhaps the classroom rules and procedures become less explicit and constraining for the more mature teenager.

DISCUSSION/IMPLICATIONS

This study has shown that students' perception of the social environment of learning has changed significantly during the four year period, 1972 to 1976. The changes are in a conservative direction with classes seen as more formal, organized and goal-directed. Furthermore, students perceived the learning envirohment more satisfying in 1976.

Significant subject and grade level differences were also found in this study. Perceptions in science classes suggested an activity-prone environment with strong student interactions, while math was more difficult and goal directed.

Strong junior-senior high differences were noted which reflect, in general, the volatile nature of early adolescents. Classroom climates mirror

quite well the presumed activity and tension characteristic of the 12-14 year old child.

Science classes and junior high classes were seen as more formal than their comparison groups. These results are contrary to the activity-prone and volatile explanations of this paper, yet are consistent with previous research.

The return to a more traditional learning environment would appear to have implications for teacher educators and curriculum developers. The educational pendulum, at least in science and math classes, seems to be moving back from the activistic climate of the late 60's and early 70's. The perceptions of students seem to reflect the back-to-basics movement now gathering momentum in this country. The return to more conventional texts after the curriculum reform of the 60's is another symptom (perhaps a cause) of this change. The claims by teachers and administrators that the educational scene is shifting are given strong support in the current study.

These shifts give rise to a challenge to educational policy makers to capitalize on the changing educational environment to provide improved education for America's youth. Teachers using curricula and methodologies which were appropriate in an earlier setting may now find those techniques in conflict with the current social system. Educators must be sensitive to the learning environment changes and try to find ways to improve student learning by utilizing the predominant environmental characteristics.

Further research is needed to answer questions about effective teaching in a variety of educational environments. For example, why do students learn

more in a climate they perceive to be difficult? To what extent are social conflicts like friction and cliqueness deterrents to learning? How can we maximize learning in the volatile climate of junior high schools? What climate characteristics of science and math classes are desired goals in and of themselves? Are there learning environment characteristics of science classes that help to explain the declining enrollments in secondary level science?

Answers to these and other questions which grew out of analysis of the socio-psychological processes in a classroom as viewed from the learner's perspective should help us to reach our common goal; to provide an optimum learning environment for each child.

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